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Some Results Of The Study Of The Less Soil In The Territory Of Mongolia

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ABSTRACT: In connection with the regional climatic and geographical features of Mongolia, loose soil deposits of the Quaternary period of the Cenozoic era are common at the depth of the foundations of buildings and below, such as loess-like subsidence and swelling clay soils, permafrost soils, heaving soils during seasonal freezing, eluval, etc. From this, the innovative application of optimal experimental and theoretical solutions for foundations and the preparation of artificial foundations, taking into account regional characteristics, is an important scientific and national economic task**.**

KEYWORDS:initial settling pressure, initial settling moisture, soaking, relative settling, pile foundations, artificial foundations.

I. INTRODUCTION

The regularity of the process of changing the stress-strain state of loess-like subsiding soils due to technogenic soaking is subject to the general theory of soil mechanics, but each region of the world has its own distinctive feature in terms of soil conditions. Proceeding from this, the modern experimental and theoretical study of the mechanics of subsiding soils and geotechnical science, aimed at developing optimal experimental and theoretical solutions for foundations and the preparation of artificial foundations, taking into account regional features, is an important scientific and national economic problem.

In accordance with the administrative division, 5 aimak centers and more than 100 somon centers and settlements were built on loess-like soils in Mongolia, including the city of Darkhan built in the 1960s, in the 1970s, Erdenet, in the 1980s, other new cities, such as the city of Khutul and many other settlements, and infrastructural engineering structures were erected. According to the experience of construction and operation of buildings and structures built on loess-like subsiding soils in Mongolia and other countries of the world, cracks and damage are formed in many buildings due to subsidence deformation. Buildings with cracks and damage, even after repair and reinforcement work, do not fully restore their original state, their seismic resistance decreases by 1-2 points, the likelihood of risk increases, and financial resources are spent inefficiently.

To study these problems, V.A. Obruchev [1], J.G.Anderssen [2], R.Ch.Andrews [3], Yu.V. Syrokomsky [4], Yu.A. Bagdasarov [5], T.G. Ryashchenko [6], A. Anand [7], D. Dashjamts [8], N. Batsukh [9], S. Nyamdorj [10] and other researchers devoted their experimental and theoretical work to identify the regional features of loess-like subsidence soils in the territory of Mongolia and development of optimal solutions for bases and foundations.

II. RESEARCH METHODS

In the 1900s, D. Dashzhamts [11] studied the origin, distribution, and physical and mechanical characteristics of subsiding loess-like soil, common in Mongolia, and compared it with similar parameters of subsiding soils, common in the Eurasian regions, the Transcaucasus, the countries of Central Asia and Siberia.

S. Nyamdorj [12] developed this study and determined the regional features of loess-like subsidence clayey soils in Mongolia by comparing the indicators (Table 1) of similar soils common in Southwestern Siberia, including the regions of Novosibirsk, Barnaul, Irkutsk, Transbaikal Territory, Ulan-Ude, Western and Central Mongolia, Nort-heast China (Ryashenko T.G., Akulova V.V. [13]).

Table 1. Table for comparing the physical and mechanical properties of loess soils common in the territory of the Euro-Asian region

	Characteristics, region	n, %	γ_s, кН/м^3	γ, кН/м^3	W, %	W_L, %	W_p, %	I_p, %	ε_{sl}, %
	Uzbekistan	37-59	26.8-28.0	12.1-18.3	0.08-0.12	25-30	17-20	5-100	3-15
	Georgian	39-55	26.7-27.4	15.8-19.2	0.13-0.17	28-44	14-26	14-18	1.0-15.3
	Don in Rostov	38-56	26.7-27.2	14.0-19.3	0.12-0.15	24-40	12-24	2-30	1.6-13.0
	Eastern Siberia (Russia)	41-58	26.3-27.6	12.5-18.2	0.08-0.12	21-34	12-20	9-14	1.0-5.0
	Azerbaijan	42-57	26.7-27.7	13.5-18.8	0.12-0.17	23-42	15-28	8-14	2.2-14.8
	Mongolia	33-41.5	26.9-28.1	12.0-21.3	0.05-0.08	17-30	15.5-18	13-21	1.5-16
	Novosibirsk, Barnaul	37.5-41.3	25,9-28,6	13.2-16.7	0.08-0.11	21-34	14.2-23.2	11-18	0.9-7.6
	Irkutsk	40.9-51.5	24,2-31,1	15.9-18.3	0.11-0.14	24-33	13.2-21.7	8-14	1.3-13.1
	For the Baikal Ulaan-Ud	46.3-53.2	26,2-28,7	14.8-17.5	0.10-0.12	2-34	14.2-22.6	9-17	2.1-14.8
	Northeast China	45.7-52.4	27,5-28,2	15.2-16.3	0.06-0.11	20-32	14.1-20.9	6-9.7	2.4-11.5
	Western Mongolia	42.5-49.8	25,6-27,5	14.4-15.2	0.07-0.09	21-34	15.3-21.7	8.5-13.5	3.1-12.4
	Southern Mongolia	46.5-51.3	24,2-28,3	15.1-17.2	0.05-0.08	23.1-27.2	14.8-20.3	6.2-10.1	3.4-11.3
	Darkhan-Selenge	49.2-58.3	23,1-25,7	14.1-15.8	0.05-0.06	21-33	15.3-21.2	7.4-11.4	2.4-12.6
	Erdenet-Orkhon	46.2-53.1	22,9-24,8	13.8-14.9	0.06-0.07	23-35	14.3-20.8	8.3-12.7	3.0-14.1

III. INITIAL DRAWDOUN PRESURE

On fig. Figure 1 shows the dependence curve of the initial subsidence pressure (P_{sl}) of the loess-like soil in the territory of the city of Darkhan. According to the analysis of the dependence curve of the relative subsidence value on the initial subsidence pressure ε_{sl}=f(P_{sl}) of loess-like silty sandy loamy soil fluctuates within $P_{sl} = 0.25 \div 1.50$ kg/cm^2.

Figure 2.1. Curves of dependence of the relative subsidence of loess-like subsidence soil on the initial subsidence pressure $\varepsilon_{sl} = f(P_{sl})$.

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IV. INITIAL SUBSIDENCE MOISTURE

On fig. 2...4 shows the dependence curves of relative subsidence on humidity and pressure $\varepsilon_{sl} = f(W_i, P_i)$ of the site for field testing of driven piles in Darkhan (Fig. 2).

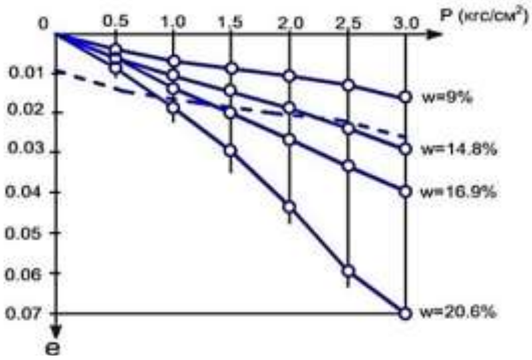

Figure 2. Dependence curves $\boldsymbol{\varepsilon_{sl} = f(W_i, P_i)}$. (S.Nyamdorj. 2003)

According to the analysis of the dependence curve $\boldsymbol{\varepsilon_{sl} = f(W_{i,}, P_i)}$ with subsiding soil moisture up to W=9.0% or depending on the moisture level ($\mathbf{S_r}$≤0,5) and at pressure $\mathbf{P_i}$≤3, 0 kg/cm2 no subsidence detected. At pressure P=1.5 kg/cm2 and humidity W=20.8% or $\mathbf{W_{sat}}$, subsidence ($\boldsymbol{\varepsilon_{sl} \geq 0.01}$) starts. At pressure P=2.0 kg/cm2 and moisture content W=14.0%, and at pressure P=2.5 kg/cm2 and moisture content W=11.2%, subsidence starts accordingly (Fig. 3).

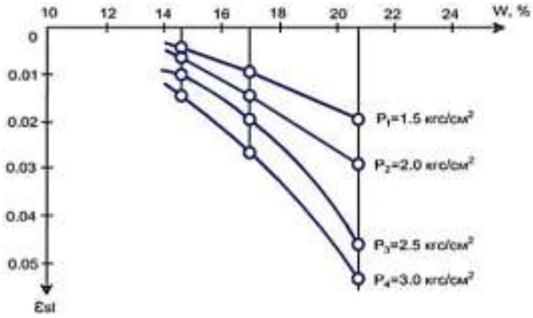

Figure 3. Comparison of the dependence curves $\boldsymbol{\varepsilon_{sl} = f(P_1, P_2, P_3, P_4)}$ at constant humidity (S.Nyamdorj. 2003)

According to the analysis of dependence curves$\varepsilon_{sl} = f(P_i)$ with natural soil moisture W=const and pressure $\mathbf{P_1}$=1.5 kg/cm2, no subsidence was detected if pressure $\mathbf{P_2}$=2.0 kg/cm2, $\mathbf{P_3}$= 2.5 kg/cm2 and $\mathbf{P_4}$=3.0 kg/cm, relative subsidence index is within $\boldsymbol{\varepsilon_{sl}}$=0.021÷0.54. For example: at a pressure of $\mathbf{P_4}$=3.0 kg/cm2, the value $\boldsymbol{\varepsilon_{sl}}$=0.54, which calls for when the soil moisture level changes from a wet to a water-saturated state, there is a possibility of uneven subsidence of the base, significantly exceeding the allowable value (Fig. 4).

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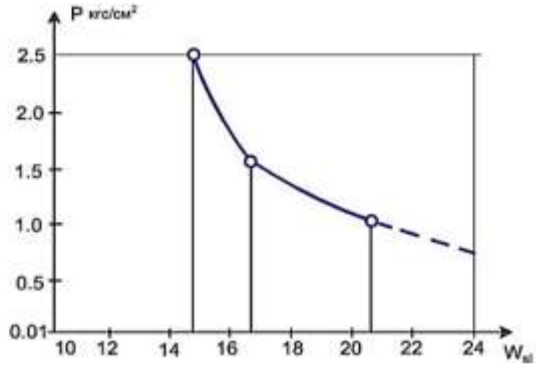

Figure 4. Dependence curve $W_{sl} = f(P_i)$ for subsiding sandy loamy soil of Darkhan (S.Nyamdorj. 2003)

According to the analysis of the dependence curves of the initial subsidence moisture and pressure $\mathbf{W_{sl}}$=f($\mathbf{P_i}$), the following was established: at pressure $\mathbf{P_1}$ =1.0 kg/cm2, soil moisture W≥ 20.8% or when water is saturated, soil subsidence is not formed. And at pressure $\mathbf{P_2}$=1.5 kg/cm2 initial subsidence moisture $\mathbf{W_{sl}}$=16.3%; at pressure $\mathbf{P_3}$=2.0 kgh/cm2 initial subsidence moisture $\mathbf{W_{sl}}$ = 15.5%; at pressure $\mathbf{P_4}$=2.5 kg/cm2, the initial subsidence moisture $\mathbf{W_{sl}}$ = 14.7%, the latter show that loess-like subsidence soils common in the territory of Mongolia do not subside at pressure from their own soil and water saturation, and at additional pressures from 1.5-2 .5kg/cm2 and moisture content of 16.3-14.7% begin to show subsidence.

V. PESULTS AND DISCUSSION

Based on these provisions, based on the results of the above-mentioned theoretical and experimental studies, construction experience and lessons learned on the causes of subsidence and deformation of buildings built on subsidence soils, the main solutions that meet the regional characteristics of Mongolia are:

1. Due to the fact that the territory of Mongolia is located at the height of the Central Asian Plateau, the thickness of the vegetation layer and snow cover in winter is relatively small, the average annual temperature of the territory is about 0℃, and the average number of days with a negative temperature is about 200. According to the BNbD norm (SNiP) "Climatology of the Territory of Mongolia" the depth of seasonal soil freezing is 3.5÷5.0 m, in rare cases permafrost is found under it.

2. As a result of the sublimation process of permafrost (the last Altai-Tunguska ice age, which covered most of the Euro-Asian region 15-18 thousand years ago) of seasonal deep frozen soils, occurring for many years in deep frozen subsiding soils, the structure is decompressed, as a result of the latter, porosity n = (50÷65)%, porosity coefficient e = (0.70÷0.84) , density of dry soil ρ_d= (1.35÷1.60) t/m3 or undercompacted, moisture content of sandy loam W=(0.04÷0.06) and loam W=(0.05÷0.08), as a result repeated freezing and thawing occurs cracking and grinding of the solid part of the soil, based on this, the content of dusty parts is 50-60%.

3. Settling clayey soils of Mongolia in natural conditions have a relatively high content of water-soluble and slightly soluble carbonate and other salt compounds and, due to their cemented and crystallized structural bonds, have relatively high mechanical properties, but mechanical properties due to the weakening of structural bonds during soaking are sharply reduced to the value c=7.0÷10.2 kPa, φ=16 ÷20°, E=3.5÷4.5 MPa and subsidence begins depending on the type of soil at pressure P=1.5 kg/cm2 and W=(6.7 ÷8.6)% or W_{sat} while the relative subsidence index is ε_{sl}>0.01. At pressure P=2.0 kgh/cm2 and W=(6.1÷7.6)%, subsidence begins, and at pressure P=2.5 kg/cm2 and W=(5.2÷6.9)% the slump begins. These moisture values are calculated respectively at given pressures as the initial subsidence moisture W_{sl}.

4. Loess-like clayey soils, common in some regions of Mongolia, do not belong to the category of subsiding soils according to the soil classification standards of other countries, including Russia, but at different pressures and increasing humidity, a solid subsidence is observed, so there is a need for classification by indirect signs.

Optimal foundations and artificial bases.

Taking into account the established regional features, a theoretical and methodological justification for the innovative use of scientific methods has been developed, taking into account the soaking of the subsidence base of buildings. The issues of construction and operation of

buildings, structures built on loess-like subsidence deposits and in areas with high seismic activity (7, 8 and 9 points) of Mongolia are poorly studied from a scientific point of view (S. Nyamdorj [14]). On the basis of the studies carried out, rational types of foundations and artificial foundations of building structures were established, taking into account the regional features of the territory of Mongolia:
From the types of foundation:
- driven and bored pile foundations;
Of the types of artificially improved bases:
- foundations in tamped pits;
- compaction of subsidence soil with a heavy rammer;
- soil foundation pads with geosynthetic reinforcement;
- grouting and silicification to increase the density of the base of new and exploited deformed buildings, including historical buildings and structures.

VI. CONCLUSION

Taking into account the established regional features, a theoretical and methodological justification for the innovative use of scientific methods, such as a pile foundation, a foundation in a rammed pit, and artificial improvement of the subsiding soil of the base, including compaction with a heavy rammer, a soil cushion with geosynthetic reinforcement, and chemical fixation by cementation methods, has been developed and silicification, taking into account the soaking of the subsidence base of buildings and structures.

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